




The Maintenance Performance System



Dr. Douglas J. Bobko
Research Psychologist
Army Research Institute
Alexandria, Virginia

The Maintenance Performance System (MPS) is a computer-based management system designed to improve the conduct and quality of maintenance training at the direct support level; it has been in operation at a FORSCOM maintenance battalion for nearly one year. An evaluation of the system suggests that MPS monitors daily maintenance activities with relative ease and accuracy. Moreover, MPS-generated skill and training information is used by shop personnel to diagnose skill deficiencies and to guide technical training of individual repairmen.



AD P001293

The proper and continuous maintenance of Army vehicles and other equipment is crucial to achieving combat readiness. However, a number of reports have indicated that, at both the organizational and direct support level, equipment maintenance procedures are less than optimal. Typical of recurring problems in maintenance operations are these: faulty diagnosis, failure to recognize equipment failures, unnecessary part replacement, and failure to conduct on-the-job training.

In an effort to help correct these maintenance deficiencies, and with the assumption that effective maintenance training helps ensure efficient maintenance operations, the Army Research Institute (ARI) developed the Maintenance Performance System (MPS).

The Maintenance Performance System

The primary goal of MPS is to improve the conduct and quality of on-the-job training of repairmen in their performance of technical tasks at direct support battalions (a more extensive system for use at the organizational level is now being designed). To accomplish this, MPS provides unit management with current information about the experience, training and skills of maintenance personnel, and then guides the manager toward selection of available training methods and materials to meet skill and performance needs.

Integration Into Normal Operations

The structure of MPS and its integration into normal operations are shown in Figure 1. Daily changes in both equipment status and repairmen experience are recorded and fed into a computer file; in turn, information about shop performance on an aggregate and individual level is prepared in report form. These reports from MPS are given to battalion and company level managers who use them to diagnose maintenance performance deficiencies. Managers can then use specific system-derived guidance to match training resources with training needs and to develop an on-the-job training program.

It is important to note that MPS differs from the current Army Maintenance Control System (MCS). MCS is primarily designed to provide information about the status of equipment as it passes through the shop and, unlike MPS, MCS provides no information about individual and unit skills, experience, or training.

Description of System

MPS has been in use for nearly one year by two forward support companies of a divisional FORSCOM maintenance battalion. It currently includes ten Military Occupational Specialties (MOS) and almost all of the equipment serviced by the

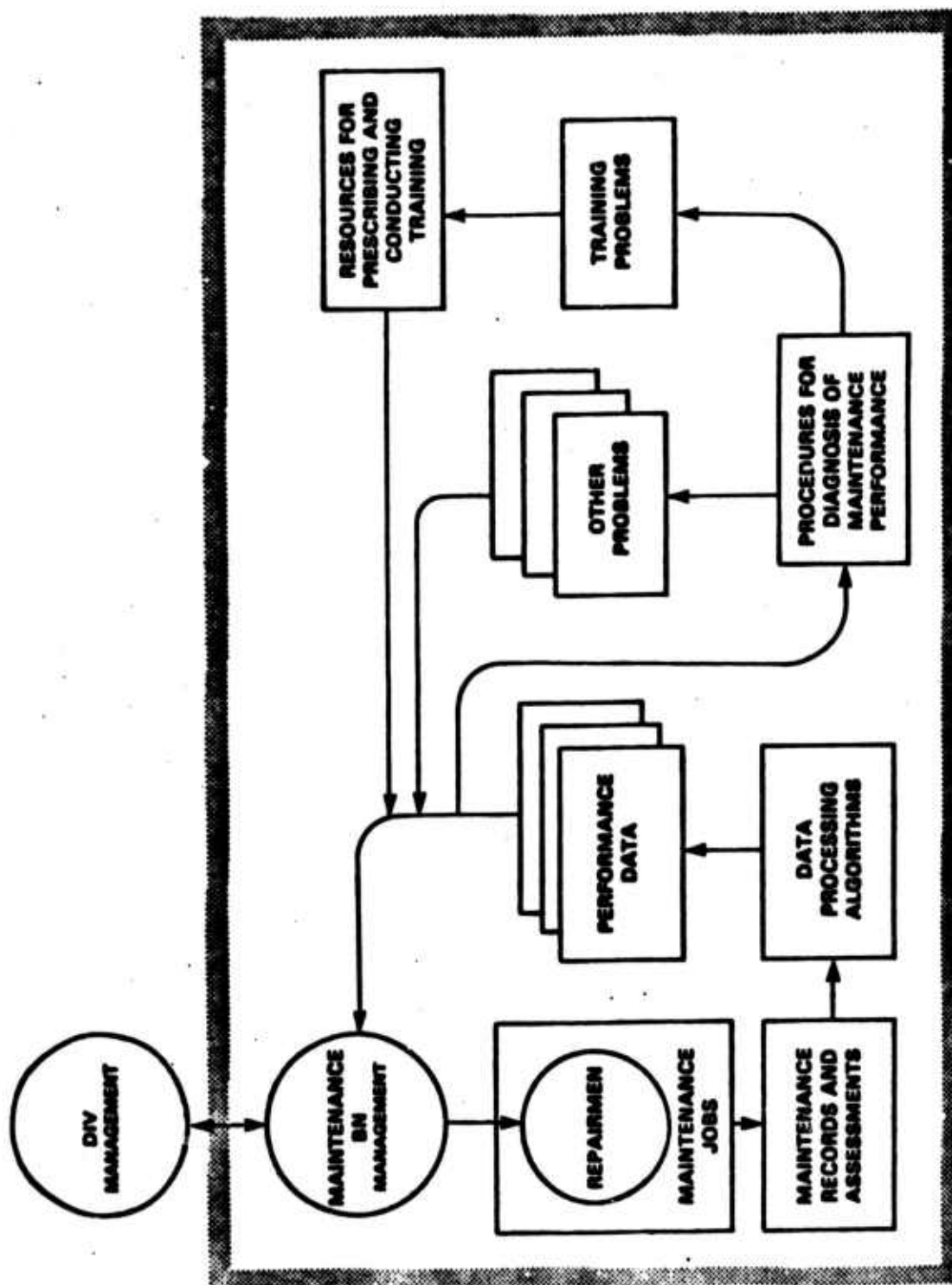


Figure 1. Integration of the Maintenance Performance System into maintenance operations.

companies. The MOSs include the high density MOSs of 63H (track vehicle repairmen), 63W (wheel vehicle repairmen), and 45K (tank turret repairmen).

Technical MOS supervisors feed information into the system through a set of five simple input forms. Based on observations to date, supervisors spend about ten minutes each week completing them. The information required on each form is described in Table 1.

TABLE 1. DATA COLLECTION FORMS

<u>Input Form</u>	<u>Title</u>	<u>Use</u>
1	Job Order Status	One for each job; records time of each change of job status
2	Job Performance	Records amount of time each repairman works on each job
3	Daily Man-Hour Availability	For each repairman, records available hours, direct hours and overtime
4	Training/Performance Demonstration	Records accomplished training or testing for each repairman
5	Task Experience	Repairman entering system report prior experience on each task

Day to day operation of MPS is accomplished by a junior enlisted clerk in grade E3 or E4. The clerk is responsible for collecting the input forms, key encoding the data into the computer (presently an IBM 5120), generating computer-printer reports, and distributing the reports. The clerk works full time at these duties.

In all, there are nine different MPS reports and two tables (see Table 2). One table lists the complete roster of each company and is distributed to the company office. It is used to keep track of the number and type of personnel in the unit on a bi-weekly basis. The other table contains a list of comments about local conditions that may affect the interpretation of reports. For example, this table would record when training holidays occur, because training holidays would affect the time and direct labor available for maintenance.

There are 5 different reports which contain data that reflect the operational status of the unit and these are delivered to relevant personnel on a bi-weekly schedule. Maintenance managers use information about man-hour use, time-to-repair, and time in each job status (i.e., awaiting parts, in-shop, etc.) to locate deficiencies in maintenance performance and other problems. Maintenance managers are guided in the diagnosis of problems by an "Interpretation Guide" that is specifically keyed to MPS.

Four other reports, which are produced every six weeks, contain data that are particularly relevant to the analysis of training needs and the guidance of training activities. For example, the Individual Skill History report contains a record of each individual's experience on each MOS technical task. Experience on a task includes the job exposure that occurs when a soldier is given a task to perform, more formal training that is provided to train or refresh skills, and demonstrated proficiency on a performance-based test. The Individual Skill History report is essentially an automated procedure for recording the tasks that each soldier performs and is much like a job book. It also serves as the basis for the Training Requirements Summary report which actually guides training activity. This report lists those individuals who have insufficient experience on each task and ranks the need for training according to the degree of experience and the criticality of the task. Training managers can use this report to identify those individuals who most need training on each task.

TABLE 2. MPS REPORT INFORMATION

Table 1	Roster
Table 2	Interpretation Comments
Report 1	Man-hour Availability and Use
Report 2	Average Direct Man-hours Per Job
Report 3	Average Direct Man-hours Per Job by Equipment and Task
Report 4	Average Job Throughput Time in Days
Report 5	Average Days Spent in Each Job Status
Report 6	Skill and Growth Indices
Report 7	Skill Development Summary
Report 8	Individual Skill History
Report 9	Training Requirements Summary

MPS has been in operation for several months without the assistance of or supervision by ARI. Several visits and observations during this time have revealed that MPS functions smoothly on a day-to-day basis, e.g., forms are routinely attached to job orders and filled in, data is collected and entered into the computer regularly, and reports are printed and distributed appropriately. A more detailed analysis of MPS was conducted, however, to evaluate the accuracy and validity of MPS information, and to determine the extent to which MPS training reports affect the conduct and content of skill training in the maintenance shops.

The first objective of this evaluation was to determine the accuracy of information being entered onto the more critical MPS forms. This was done in light of the fact that MPS report interpretation and consequent command action is predicated on confidence in the accuracy of MPS statistics; data input quality is a fundamental problem for any such system.

A second objective of the evaluation was to assess the validity of MPS-generated individual skill indices. The skill index, which is assigned to each repairman, can range from 0 to 100 and it reflects the degree to which a repairman is proficient on those tasks covered by his MOS; the skill index increases each time a repairman works on a job, receives training, or passes a performance-based test on a job. (The skill index is essentially a single number describing the content of the Individual Skill History report.

Skill indices are an integral part of MPS for a variety of reasons. For battalion and company commanders, they point to current strengths and weaknesses in overall maintenance capability, and provide a measure of the growth in maintenance proficiency. For shop supervisors, the skill index is an easy reference to those repairmen who require additional training. To the individual repairman who receives a skill growth report every six weeks, the skill index can serve as a source of reward and motivation.

The third objective of this evaluation was to determine the extent to which MPS reports of job experience are used for job assignments and for setting training priorities.

Accuracy of MPS data

Most of the critical information monitored by MPS is collected on MPS Forms 1, 2, and 3. Hence, a sample of these forms in each company was examined and checked for accuracy.

MPS Form 1 (Job Order Status). For two companies and four MOSs, a total of 67 forms were examined. The information contained on these forms was compared with similar information contained in the job folder which normally follows a job through the shop; shop officers were also questioned about data entries on this form. It was found that the information contained on MPS Form 1 is generally consistent with that of DA Form 2407 and with verbal reports from shop officers. The most frequent problem was an incorrectly entered or omitted job code; this occurred on six of the forms examined.

selection, these forms represented shop work completed within the last 48 hours. The repairman (and their supervisors) listed on these forms were questioned about the jobs they had recently performed, and the length of time each job required. In each case, the names listed on Form 2 were consistent with reports from repairmen and supervisors, i.e., those repairmen who performed the job received credit for it.

The accuracy of job completion time data was more difficult to determine, however. Since there are occasional interruptions in work, and because start and stop times are not recorded with a stopwatch, job completion times are generally rough estimates. Based on reports from repairmen and supervisors, the total job completion time is typically rounded up to the nearest hour or half hour, so that the magnitude of error increases as the job completion time decreases. For this sample of forms, however, there was no instance in which repairmen's reports of job completion time differed from MPS data entries by more than 60 minutes.

MPS Form 3 (Daily Man-Hour Availability). Fifty-five forms were reviewed, which represent both companies and four MOSs. From interviews with shop supervisors, it is clear that available man-hour entries are accurate but that the direct man-hour entries are predominantly inaccurate. For example, it is a common practice with Form 3 to enter 7 or 3 direct man-hours for repairmen who worked only 4 or 5 hours. That direct man-hour entries are inflated was confirmed by a cross-check for Form 3 with Form 2 (which records job performance time for each repairman).

Validity of MPS Skill Index

To assess the validity of the MPS skill index, the indices were compared with independently obtained job performance ratings of each repairman. In short, each repairman tracked by MPS was rated by both his supervisors and his peers. Ratings were made with the use of an anchored scale, where a 0 performance rating indicated a repairman who required constant and total supervision on a job, 50 indicated that some supervision was required, and a performance rating of 100 meant that the repairman could perform a task successfully without any supervision. Three ratings were obtained for each repairman: the first rating was to indicate a repairman's general performance in his MOS, and the remaining two ratings were to indicate his performance on two different but specific tasks (which differed for each MOS). In all, usable ratings were obtained from 20 supervisors and 50 repairmen, representing four MOSs (63H, 63G, 52D, 45K) and three companies.

Pearson product-moment correlations were calculated to determine the relationship between MPS skill indices and performance ratings; for each rater, a correlation was obtained between the performance ratings he assigned to repairmen and those repairmen's skill indices. While only a handful (16%) of these correlations were found to be significant, the majority (86%) of them were positive. In all, these results suggest a small yet positive relationship between MPS skill indices and performance ratings.

Structured interviews were conducted with shop supervisors, team leaders, and selected repairmen to determine what effects MPS feedback has on maintenance training, job assignment, and morale or motivation.

Although attitudes toward MPS as a training information source and guide were generally positive, the actual use of MPS feedback for training purposes was varied and apparently related to two factors, supervisory level and MOS density: Warrant officers, for example, use MPS feedback more often than team leaders, and MPS reports play a greater role in larger maintenance sections than in smaller ones.

MPS skill training reports were used for training purposes in the following ways: (1) to assign jobs to work teams, i.e., a team which had done some job least often would be assigned that job over other teams, (2) to temporarily shift a repairman from one team to another in order to gain experience on some job, (3) to serve as a memory refresher about which repairmen require training on critical skills, and (4) to log entries into job books.

Interviews with repairmen revealed that individual skill history reports had little effect on morale or motivation for two reasons. First, the skill history reports are distributed infrequently (every six weeks) and second, the reports list which jobs have been performed but not the quality of performance.

Discussion

The primary purpose of MPS is to improve the conduct and quality of on-the-job maintenance training. Toward this end, and as a prototype system, MPS appears to have worked well. It has been shown to be a system in which daily maintenance activities are monitored with relative ease and accuracy. Moreover, MPS provides unique maintenance training information and guidance which is used for training purposes by shop personnel.

The results of the evaluation reported here and other observations made during the past year suggest several improvements or modifications of MPS. For example, modification of the MPS computer program would allow a calculation of direct man-hours from information on MPS Form 2, thus increasing the accuracy and reliability of the man-hour availability and use reports (and eliminating all or at least part of MPS Form 3). Another modification would be to increase the frequency of distribution of individual skill history reports, and hence increase the potential this feedback has for motivation and morale. One other important improvement of MPS now under development is a method of reflecting the proficiency with which tasks are performed; currently, two repairmen will receive the same amount of credit for completing a task regardless of the quality of their work.

ARI is now working toward a link between MPS and interactive video-disc instruction. A scenario for the near future is this: After signing on at a computer terminal, a mechanic is presented with a summary of his

current work and training history. The computer then identifies the mechanic's training deficiencies, and directs him toward a specific videodisc lesson available for use on that terminal. The computer monitors the progress of the mechanic as he completes the lesson, and updates his training experience accordingly.

Finally, it should be noted that a maintenance system like MPS can have an impact on more than the unit in which it functions. Specifically, maintenance performance information can be fed back to the institutional training base for use in curriculum design, and it can provide high quality reference data to the equipment design process.